



Range extension of *Relicina subabstrusa* (Parmeliaceae, lichenized Ascomycota) in Argentina and its distribution pattern in the Neotropics

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Abstract

Relicina subabstrusa is known from a few scattered records in the Neotropics. This species lacks any propagules and has a black lower surface and coronate apothecia. This paper extends the known distributional range of *R. subabstrusa* in Argentina and maps its geographic distribution in the Neotropics. Notes on similar taxa and an updated key for the identification of the Neotropical species of the genus are provided.

Key words

Parmelioid lichens; norstictic acid; bulbate cilia; coronate apothecia.

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Introduction

The parmelioid genus *Relicina* (Hale & Kurok.) Hale was erected by Hale (1974) to accommodate species previously included in *Parmelia* subgenus *Parmelia* section *Bicornutae* series *Relicinae* Hale & Kurok. (Hale and Kurokawa 1964, Hale 1974). Its characteristic features include the yellowish green thallus with cortical usnic acid, marginal bulbate cilia, and bifusiform conidia (Hale 1974, Elix 1993). The bulbate cilia are a distinctive character in the Parmeliaceae as it is also present only in *Bulbothrix* Hale, which is differentiated by having cortical atranorin (Elix 1993). *Relicinopsis* Elix & Verdon is a closely related genus which shares with *Relicina* the cortical usnic acid, but differs by its non-bulbous marginal cilia and fusiform conidia (Elix 1994, Crespo et al. 2010).

Phylogenetic studies based on molecular data have shown that *Relicina* belongs to the *Parmelia*-clade and constitutes a monophyletic genus, with *Relicinopsis* nested within, being *Bulbothrix* only distantly related (Crespo et al. 2010). Thus, bulbate cilia might have evolved independently in both genera (Crespo et al. 2011).

Relicina is a tropical to temperate genus with centers of species diversity in eastern Asia and Australasia (Elix 1993, Crespo et al. 2010), where there is a high degree of endemism (Hale 1975, Elix 1991). It is unknown for Europe or central Asia and rarely reported for East Africa (Elix 1991). There are approximately 56 species known at present (Hale 1974, 1975, Streimann 1986, Elix and Johnston 1986, 1988, 1990, Elix and Nash 1995, Elix 1996, 1998, 2007, Noicharoen et al. 2003, Lumbsch et al. 2011), of which 8 are currently known in the Neotropics.

Table 1. Records of *Relicina subabstrusa* from the Neotropics available in literature. Herbaria acronyms are according to Thiers (2017). n/d = no data.

| Country | Department/province/state | Locality | Latitude | Longitude | Elevation (m) | Voucher | Reference |
|-----------|-------------------------------------|--|--------------------|--------------------|---------------|--|-------------------------------|
| Argentina | Formosa province, Laishi department | 11 route, between Mbiguá and Lindo streams | 26°01'30.25" S (*) | 58° 29'30.38"W (*) | 63 | Arbo 2696 (CTES) | This work |
| Brazil | Ceará state | Floresta Nacional do Chapada do Araripe | 07°17'36" S | 39°33'67" W | n/d | Menezes s.n. (ISE) | Menezes (2013) |
| | Matto Grosso state | Santa Anna da Chapada, Bocca da Serra | 15°26' S (*) | 55°45' W (*) | n/d | Malme s.n. (S, lectotype) | Lynge (1914) |
| | | Serra do Cachimbo, along the Cuiabá-Santarem highway (BR-163) | 09°35' S | 55° W | n/d | n/d | Brako et al. (1985) |
| Guyana | Minas Gerais state | Catas Altas, Serra do Caraça, Caraça Natural Park, beginning of the trail to the Cascatona | 20°07'0.8" S (*) | 43°29'37.88"W (*) | 1350 | Marcelli and Ribeiro 31979 (SP) | Ribeiro (1998) |
| | Río Grande do Sul state | Tiradentes, base and ascent of Serra do São Jose, by the sidewalk | 21°06'27.83" S (*) | 44°11'28.71"W (*) | 1020 | Marcelli et al. 25748 (SP) | Ribeiro (1998) |
| | | Viamão, Itapoã | 30°04'57.56" S (*) | 51°01'16.55"W (*) | 79 | Fleig 1360 (ICN) | Fleig (1985) |
| Paraguay | Upper Demerara-Berbice region | Porto Alegre, Morro Santana near Mabura Hill, between the Essequibo river and the Demerara river, about 180 km SSE of Georgetown | 30°03' S | 51°08' W | 300 | Fleig 3342 (ICN) | Fleig (1990) |
| | n/d | n/d | 05°20' N | 58°10' W | n/d | Cornelissen and Steege s.n. (U) | Cornelissen and Steege (1989) |
| | | | 25°27'43.66" S | 56°02'24.4" W | 348 | Balansa s.n. (H) | Hale (1975) |
| Venezuela | Falcón state | San Luis mountain range, surroundings of Piedra de La Campana, between Carrizalito and Cucaire | 11°01'53.15" N (*) | 69°46'34.71" W (*) | 1200 | López-Figueiras and Wingfield 22378 (MERF) | López-Figueiras (1986) |
| | Trujillo state | La Cristalina paramo | 09°14'40.83" N (*) | 70°19'38.71" W (*) | 2000–2300 | López-Figueiras and Keogh 11336B (MERF) | López-Figueiras (1986) |
| | | Las Piedras de Las Palmas, Carache-Agua de Obispo route | 09°44'02.35" N (*) | 70°05'25.21" W (*) | 2300 | López-Figueiras and Hale 19538 (MERF) | López-Figueiras (1986) |

* Georeferenced with Google Earth™ (datum= WGS84).

Among them are the endemics *R. colombiana* Elix & Sipman, *R. eximbricata* (Gyeln.) Hale, *R. incongrua* Hale, *R. relicinella* (Nyl.) Hale, *R. stipitata* Elix, *R. xanthoparmeliformis* Elix & T. H. Nash, and the more widely distributed *R. abstrusa* (Vain.) Hale and *R. subabstrusa* (Gyeln.) Hale. During an investigation of the Parmeliaceae from northeastern Argentina, *R. subabstrusa* was found for the first time in the country. In this paper, this species is described and illustrated, and its biogeographic pattern in the Neotropics is discussed.

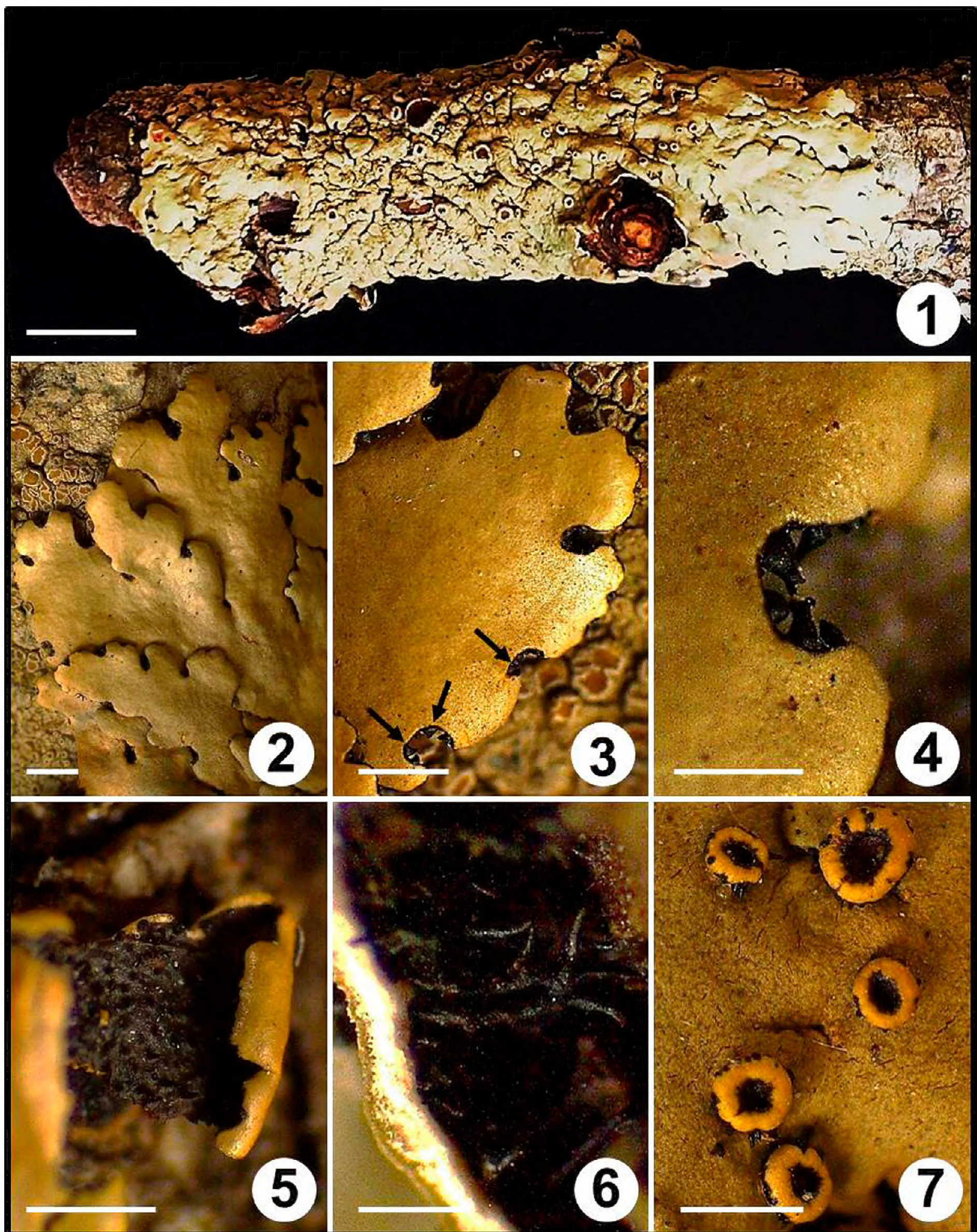
Methods

The material studied was collected in Formosa province (Argentina) and it is preserved in the Instituto de Botánica del Nordeste herbarium (CTES). Morphological analysis was carried out using standard stereoscopic (Leica MZ6) and compound light microscopes (Leica CME). Apothecia and pycnidia were sectioned by hand with a razor blade and then mounted in 5% KOH for examination. Measurements of the ascospores and conidia were made with objectives at 400 and 1000× magnification. Lichen substances were identified with spots tests with 10% KOH (K), sodium hypochlorite (C), and K followed by C (KC), UV fluorescence, and thin layer chromatography (TLC) with solvent C following standard methods (Orange et al. 2010). The distribution map was made using the software DIVA-GIS Version 7.5, based on records for the species available in literature (Lynge 1914, Hale 1975, Brako et al. 1985, Fleig 1985, 1990, López-Figueiras 1986, Cornelissen and Steege 1989, Ribeiro 1998, Menezes 2013) which are summarized in Table 1. Localities for which no geographic coordinates were available were georeferenced with Google Earth™.

Results

Relicina subabstrusa (Gyeln.) Hale, Phytologia 28(5): 485. 1974. Figures 1–7

Thallus foliose, yellowish green, coriaceous, corticolous, tightly adnate to substrate (Fig. 1), 5–6 cm in diameter; lobes sublinear to subirregular, anisotomically dichotomously to irregularly branched, 1–2.5 mm wide, imbricate (Fig. 2), with rounded to subtruncate apices; margin entire to crenate, with bulbate cilia (Fig. 3); cilia more concentrated at lobes axils, with generally short apices, simple to rarely with bifurcate tips (Fig. 4), 0.1–0.4 mm long. **Upper surface** shiny, smooth to rugose at center, continuous, with small irregular cracks towards the center of the thallus, weakly maculate; maculae punctiform, laminal. **Isidia** and **lobules** absent. **Medulla** white. **Lower surface** black (Fig. 5), shiny, smooth to slightly rugose, continuous, abundantly rhizinate, with or without a dark brown, shiny, rhizinate to papillate margin; rhizines simple to rarely bifurcate (Fig. 6), black, evenly distributed. **Apothecia** abundant, plane to slightly



Figures 1–7. *Relicina subabstrusa*. **1.** Thallus. **2.** Imbricate lobes. **3.** Margin with bulbate cilia. **4.** Bulbate cilia with bifurcate apices. **5.** Black lower surface. **6.** Rhizines. **7.** Apothecia with retrorse cilia. Scale bars: 1, 3, 5, 7 = 1 mm; 2 = 2 mm; 4, 6 = 0.5 mm. Photos by A. Michlig.

concave, 0.5–3 mm in diameter, adnate, laminal, margin entire to crenate, coronate; amphithecia with retrorse cilia (Fig. 7), disc imperforate, dark brown, epruinose; ascospores ovoid to ellipsoid, $6\text{--}10 \times 5\text{--}6 \mu\text{m}$. **Pycnidia** abundant, submarginal to laminal, ostiole black; conidia bifusiform, (5–) 6–8 μm long.

Spots reactions: Upper cortex K–, UV–; medulla K+ yellow turning orange, C–, KC–.

TLC: Cortical usnic acid (minor); medullary norstictic (major), connorstictic (minor to trace) and hyposalazinic (minor to trace) acids.



Figure 8. Geographic distribution of *Relicina subabstrusa* in the Neotropics based on studied material and literature (Table 1). The red dot corresponds to the new record and the gray dot indicates a collection with uncertain locality.

Material examined. ARGENTINA, **Formosa**, *Laishi*, route 11, 18 km N of Bermejo river, between Mbiguá and Lindo streams, in “quebrachal”, black, clayey soil, 24/VI/1984, leg. M. M. Arbo 2696 (CTES 90901).

Discussion

Relicina subabstrusa is characterized by having a black lower surface, coronate apothecia with amphithecia with retrorse cilia, and rhizines, norstictic acid as main medullary compound (K+ yellow turning reddish orange), and by the absence of isidia or lobules. Although Hale (1975)

has reported additional salazinic acid in material from the New World, it was not detected in the material studied in which only connorstictic and hyposalazinic acids are present, as reported by Elix (1996).

The lower surface of this species has been reported to be uniformly black (Hale 1975, Elix 1994, Kurokawa and Lai 2001). However, in the material studied there are dark brown areas while other lobes are completely black at their margins. This variation might have been seen by Lynge (1914) when he described *Parmelia abstrusa* f. *laevigata*, the form on which the type of *R. subabstrusa* is based, as he mentioned an evidently “discolored”

lower surface. Species of small “*Parmelias*” (also such as those of *Parmelinopsis*, *Parmelinella*, *Bulbothrix*, and *Hypotrachyna*), which tend to have a completely black lower surface, might occasionally have partially brown lobe apices. Apparently, in this case the maturation of the lower cortex is somewhat brief, and the brown color tends to disappear, overcome by the black mature coloration.

Although *R. subabstrusa* is reported to be emaculate (Elix 1994), the material studied appears to be weakly maculate at the very center of the thallus, with punctiform maculae similar to those in *R. abstrusa*, its presumptive isidiate morph (Hale 1975). However, these “maculae” might be a result of the relief of the upper cortex and not true maculae, as they do not appear at younger parts and, in addition, the anatomical sections of the thallus do not show interruption in the algal layer. The upper cortex is very thick and becomes very rugose at older parts, and as such the “maculae” in this material could in fact be a consequence of this factor instead of a particular pattern character of the species.

Regarding the configuration of the lobes, Elix (1994) mentioned that they are contiguous towards the center and separate to the periphery, differing from the material studied, where lobes are imbricate, similar to those in *R. abstrusa*. Lobes of the material studied are slightly wider than those reported for *R. subabstrusa*, but overall fit to the form commonly described.

The morphologically and chemically most closely related species are *R. barringtonensis* Elix, *R. filsonii* Elix & J. Johnst., and *R. polycarpa* Elix & Polyiam, which also have medullary norstictic acid and lack of isidia or lobules. However, the first two are restricted to New South Wales (Elix and Johnston 1986, Elix 1998) and the latter to Thailand (Noicharoen et al. 2003). Among them, only *R. polycarpa* has a black lower surface but differs from *R. subabstrusa* by its aggregate apothecia without thalline margin, and by producing additional medullary echinocarpic and normenegazziaic acids, both absent in *R. subabstrusa*. *Relicina barringtonensis* shares with *R. subabstrusa* the coronate amphithecia, retrorsely rhizinate at base, but it is clearly distinguished by having a brown to dark brown lower surface (Elix 1998). *Relicina filsonii* also has a brown lower surface, but its apothecia are ecoronate differing thereby from *R. subabstrusa* (Elix and Johnson 1986). The most similar species in the Neotropics is *R. colombiana*, endemic to Colombia, which shares with *R. subabstrusa* the medullary norstictic acid, but clearly differs by its saxicolous thallus with narrower lobes (0.2–1.0 mm wide), dense marginal lobules, and additional stictic and constictic acids (Lumbsch et al. 2011).

Relicina subabstrusa is a pantropical species recorded in all major land masses in tropical regions (Hale 1975, Kurokawa and Lai 2001, Wolseley et al. 2002) with the exception of Africa. Although it is considered the species with broadest geographic range in the genus (Hale 1975, Elix 1994), it is only commonly found in the Philippines (Hale 1975). In the Neotropics it is still known only by a few scattered records which are summarized in Table 1

and Figure 8. Its geographic distribution is here extended to Argentina, and it is the second species of the genus recorded so far from the country, after *R. abstrusa*.

Key for *Relicina* spp. in the Neotropics

- 1a Thallus greenish gray or grayish, with cortical atranorin. *Bulbothrix* spp.
- 1b Thallus yellowish green, with cortical usnic acid 2
- 2a Thallus isidiate or lobulated 3
- 2b Thallus not forming isidia nor lobules 4
- 3a Thallus lobulate, lacking isidia; lobes ca 0.2–1.0 mm wide; medullary norstictic, stictic, and constictic acids *R. colombiana*
- 3b Thallus isidiate, lacking lobules; lobes ca 0.5–2.0 mm wide; medullary norstictic and connorstictic acids *R. abstrusa*
- 4a Thallus saxicolous; apothecia ecoronate; cilia weakly inflated; with salazinic acid *R. xanthoparmeliiformis*
- 4b Thallus corticolous; apothecia coronate; cilia distinctly inflated; without salazinic acid 5
- 5a Asci multispored, containing 16–32 ascospores per ascus *R. relicinella*
- 5b Asci always 8-spored. 6
- 6a Medulla K+ yellow turning orange, with norstictic and connorstictic acids *R. subabstrusa*
- 6b Medulla K– or K+ yellow, without norstictic and connorstictic acids. 7
- 7a Medullary fumarprotocetraric and succinprotocetraric acids *R. eximbricata*
- 7b Medullary diffractaic acid 8
- 8a Lobes 0.7–1.5 mm wide; apothecia sessile; medulla without echinocarpic acid *R. incongrua*
- 8b Lobes 0.5–1.0 mm wide; apothecia stipitate; medulla with additional echinocarpic acid *R. stipitata*

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Authors’ Contributions

AM and MNB identified the material studied and wrote the text, AM prepared the figures, MNB prepared the identification key.

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